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13. ABSTRACT (Maximum 200 words)

Fundamental progress was made in the sequential and fixed sample detection and estimation of abrupt changes in stochastic systems and in the related problem of adaptive control of dynamical systems with time varying parameters. Also studied were recursive estimation and adaptive control of linear stochastic systems, where an essentially complete asymptotic solution was developed for the problem of adaptive estimation of inputs to keep the output of a system close to a fixed target. Advances were made in regression analysis of censored failure time data, inference in nonlinear regression models, and sequential analysis. Related probability theory involving boundary crossing problems and approximate distributions of maxima of random fields was developed.

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## Final Report

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Fundamental progress was made during this grant period in the detection of abrupt changes of stochastic systems and in the closely related problem of modeling and adaptive control of dynamical systems with time-varying parameters. Important advances were made in the development of a general methodology of sequential change-point detection in statistical quality control, capable of handling multivariate quality characteristics and autocorrelated observations. Fixed sample change-point problems were also studied. These developments led to advances in boundary crossing probabilities and large deviation theory of random fields.

Another fruitful direction of research was in the area of recursive estimation and adaptive control of linear stochastic systems. Efficient recursive algorithms and their statistical theory were developed for on-line estimation of parameters, and a relatively complete solution was obtained concerning the adaptive control problem of determining inputs to keep the outputs as close as possible to certain target values when the system parameters are not known in advance but have to be estimated on-line.

Important advances were also made in regression analysis of censored failure time data, inference in nonlinear regression models, and sequential analysis. New techniques involving differential geometry and martingale theory were developed and turned out to be very successful in addressing a number of long-standing problems in these areas. A new test for comparing three treatments in sequential clinical trials was introduced and its properties studied analytically and by simulation.

Students working with the investigators, who finished their Ph. D. degrees during the period covered by this report, were Joe Chang(USA), Jiayang Sun (China), Clive Loader (New Zealand), Dan Rabinowitz (USA), E. S. Venkatraman (India), Paul Zhang (China), Guangrui Zhu (China), Limin Zhang (China), Qizhi Wang (China), Heping Zhang (China), Farid Aitsalia (Algeria), Rebecca Betensky (USA).

A list of technical reports is attached.

**Report list**  
**AFO89-0355**

*The Air Force Office of Scientific Research*

*David Siegmund*

TR No.	Title	Author(s)	Date
1.	Sequential detection of change in a normal mean when the initial value is unknown, <i>Ann. Statist.</i> <b>19</b> (1991) 394-416.	M. Pollak D. Siegmund,	08-89
2.	P-values in projection pursuit.	J. Sun	08-89
3.	Tail approximations for maxima of random fields, <i>Probability Theory: Proceedings of the 1989 Singapore Probability Conference</i> (1992) 147-158.	D. Siegmund	09-89
4.	Some relations between harmonic renewal measures and certain first passage times.	G. Alsmeyer	11-89
5.	Parallel recursive algorithms in asymptotically efficient adaptive control of linear stochastic systems, <i>SIAM J. Control &amp; Optimization.</i> <b>29</b> (1991) 1091-1127.	T. L. Lai Z. Ying	11-89
6.	Recursive identification and adaptive prediction in linear stochastic systems, <i>SIAM J. Control &amp; Optimization.</i> <b>29</b> (1991) 1061-1090.	T. L. Lai Z. Ying	11-89
7.	Confidence regions in semilinear regression <i>Biometrika</i> <b>79</b> (1991) 15-31.	M. Knowles D. Siegmund	01-90
8.	On generalized renewal measures and certain first passage times.	G. Alsmeyer	02-90
9.	Inference for a hazard rate change point.	C. R. Loader	04-90

TR No.	Title	Author(s)	Date
10.	Boundary crossing probabilities for locally Poisson processes. <i>Ann. Appl. Probab.</i> 2 (1992) 199-228.	C. R. Loader	06-90
11.	On some failure data cases related to the 3 parameter Weibull distribution and the Gumbel distribution.	H. Hirose	08-90
12.	Confidence regions in broken line regression, submitted to <i>Change-point Problems: Proceedings</i> <i>of the 1992 Conference at Mount Holyoke.</i>	D. Siegmund H. Zhang	12-90
13.	Asymptotic approximations for likelihood ratio tests and confidence regions for a change-point in the mean of a multivariate normal distribution, <i>Statistica Sinica</i> 2 (1992) 69-90.	B. James K. L. James D. Siegmund	02-91
14.	A sequential clinical trial for comparing three treatments, to appear in <i>Ann. Statist.</i> 21 (1993).	D. Siegmund	03-91
15.	Confidence regions in nonlinear regression and geometry.	H. Zhang	06-91
16.	Asymptotically efficient estimation in censored and truncated regression models, <i>Statistica</i> <i>Sinica</i> 2 (1992) 17-46.	T. L. Lai Z. Ying	
17.	Asymptotic expansions for the distributions of stopped random walks and first passage times, to appear in <i>Ann. Prob.</i>	T. L. Lai Q. Wang	10-91
18.	Certainty equivalence with uncertainty adjustments in stochastic adaptive control, to appear in <i>Proceedings of Stochastic Theory and</i> <i>Stochastic Control Workshop</i> , Springer-Verlag.	T. L. Lai	01-92

TR No.	Title	Author(s)	Date
19.	An empirical Bayes approach to modeling and control of stochastic systems with time-varying parameters, to appear in <i>Proceedings of the 31st IEEE Conference on Decision and Control</i> , 1992.	T. L. Lai	02-92
20.	A study of change-point problems.	H. P. Zhang	09-91
21.	Using the generalized likelihood ratio statistic for sequential detection of a change-point, submitted to <i>Ann. Statist.</i>	D. Siegmund E. S. Venkatraman	01-92